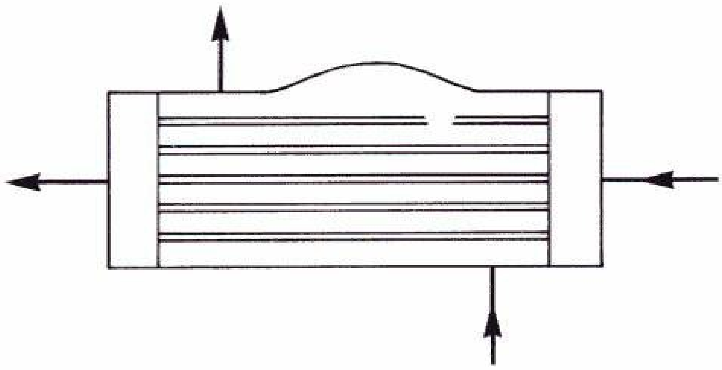
SAFETY NEWSLETTER

No. 130
TUBULAR HEAT EXCHANGERS



Best wishes for a Merry Christmas and a Safe New Year to all our readers.

ICI

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

130/1 TUBES SQUASHED BY WATER HAMMER

Earlier Newsletters (57/1, 48/2 and 43/4) have described damage caused by water hammer in steam pipes. Now another incident has occurred. Thirty tubes out of 1500 in the steam calandria which heats a distillation column were squashed or sheared off. The steam is supplied to the outside of the tubes and it is believed that the damage was caused by water hammer, or — a similar effect — collapse of a steam bubble entering the calandria when it was full of condensate.

The steam line to the calandria was fitted with only one effective trap although Engineering Specifications PI 0101 requires three. In addition, the arrangements for getting rid of condensate from the calandria were poor — it drained into the bottom of a tank, in which the level was only 1.4 m lower than the normal level in the calandria.

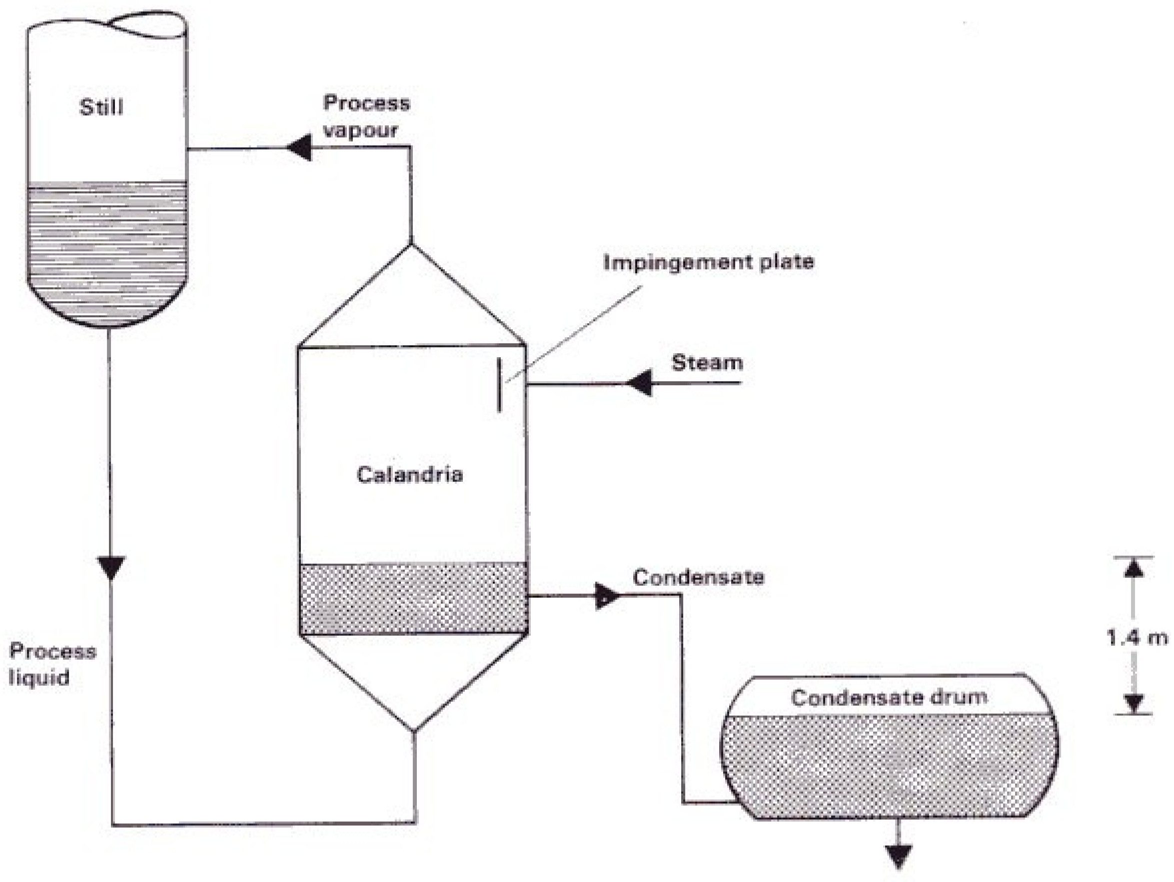
The calandria is fitted with an impingement plate so that the inlet steam does not impinge directly on the tubes. This had fallen off several times before the incident, probably as the result of blows by slugs of condensate, and was merely put back with stronger attachments.

Make sure your steam pipes are fitted with sufficient traps — and that they are kept in working order.

Make sure condensate can get away easily.

Another similar system was found on the Works.

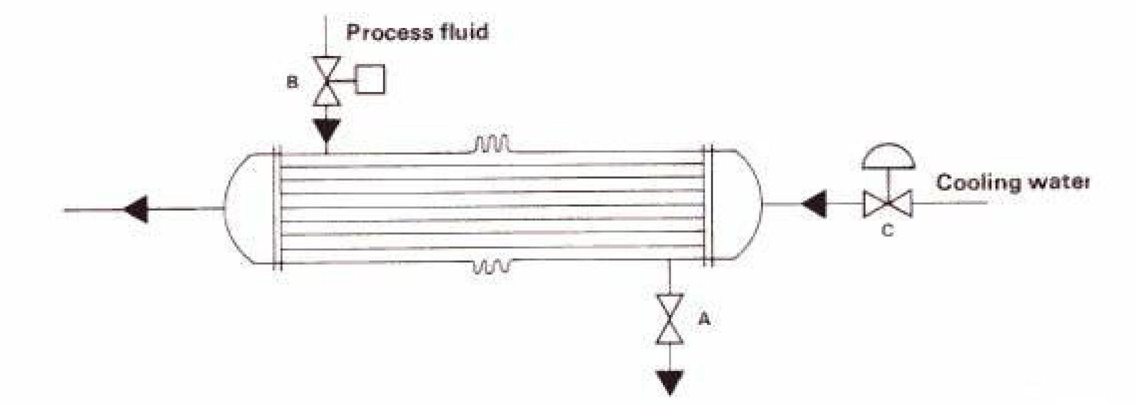
When something breaks, ask why. Don't just make it stronger.



130/2 A SPLIT IN A HEAT EXCHANGER BELLOWS

We all realise that a heat exchanger can be overpressured if the shell-side is isolated while hot fluid flows through the tubes.

It is not so easy to realise that a heat exchanger can be overpressured if the shell-side is isolated while **cold** liquid flows through the tubes. Nevertheless, this happened in the Division and caused a split in the bellows of a fixed tube-sheet exchanger.



While a plant was being shut down the hot process (shell-side) flow was stopped by closing the manual isolation valve A. At the same time the cooling water flow was greatly reduced by closure of control valve C. This allowed the tubes and shell to warm up to the same temperature as the process fluid. At a later stage in the procedure, a series of trips was initiated which closed the automatic tight shut-off valve B and fully opened the cooling water control valve C.

The sudden flow of cold water cooled the tubes, tending to contract them and draw in the tube-sheets. This increased the hydraulic pressure in the shell which was completely liquid-filled. The pressure rise was eventually sufficient to cause failure of the weakest part, the bellows.

130/3 WATER TRAPPED IN TUBES FROZE AND BURST THEM

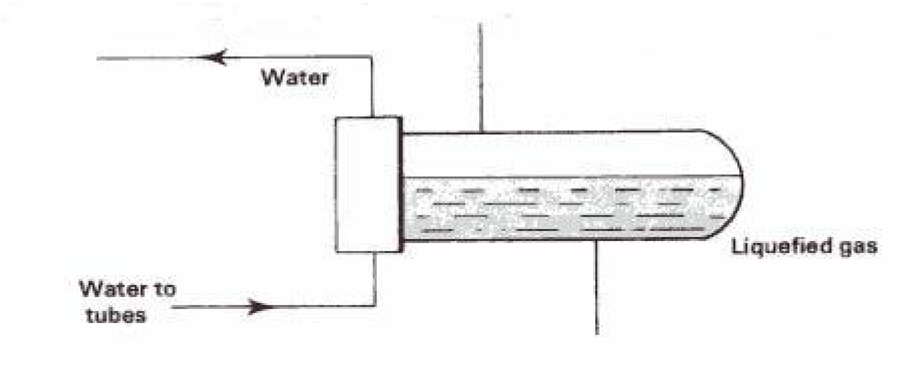
Newsletter 89/1 described how water in heat exchangers can be frozen by the evaporation of liquefied gas in the shell. The Newsletter recommended that water should be kept flowing through the tubes while the shell is depressured and that depressuring should take at least 10 minutes.

Another Company have described a similar incident on a heat exchanger which had water in the tubes and propane at 600 psig in the shell. The tubes were drained before the shell was depressured for maintenance but unfortunately the tubes were fouled and water was trapped in some of them. The water froze, rupturing 22 tubes.

The report recommends that water should be kept flowing while the shell is depressured. **Do not rely on draining the tubes.**

Keeping the water flowing will speed up depressuring because the water will provide a source of heat.

Reduction of pressure here will cause liquefied gas to evaporate and cool and may freeze the water in the tubes



130/4 AN EARLY TUBULAR HEAT EXCHANGER

As this Newsletter has been concerned with tubular heat exchangers, it may be interesting to quote the following description of one of the earliest, perhaps the earliest, use of a tubular heat exchanger. It was written by Henry Booth, George Stephensons partner in the design of The Rocket, which first operated in 1830.

"The power of a steam-engine at that time as well as now depended on the rapidity with which steam could be produced... The problem to be solved was by what contrivance the largest quantity of steam could be raised in the shortest time, and in the smallest compass... I thought this might be done. If, instead of passing the fire through the boiler by means of one large iron tube 12 in. diameter constructed of iron nearly ½ in. thick, we could carry the fire through a multitude of copper tubes only 2 in. or 3 in. diameter and about $^1/_{16}$ in. thick, the point would be gained.."

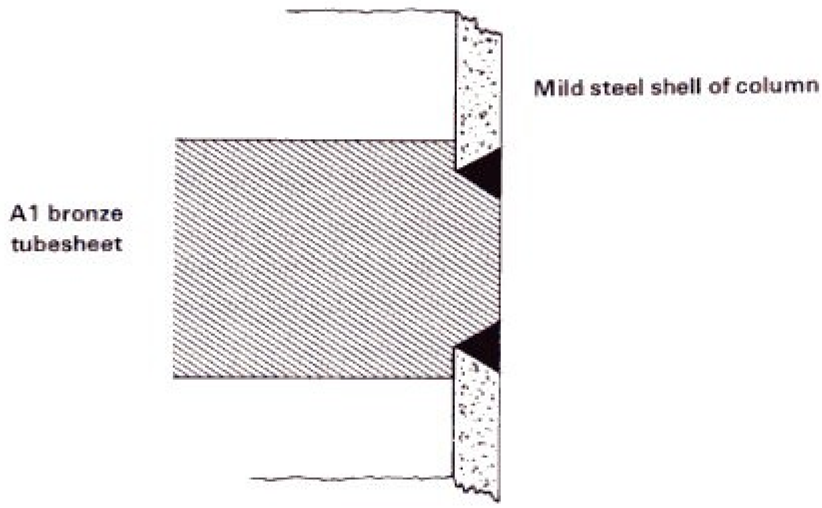
"Railway Magazine", October 1979, Vol 125, No 942, p 470.

130/5 A LOOK BACK AT NEWSLETTER 29 (MAY 1971)

Unusual methods of construction should be watched.

The recent failure of a vessel in service, fortunately not in a disastrous way, shows how alert we must be when sophisticated or unusual fabrication methods are used.

A mild steel distillation column was fitted with an internal condenser with an aluminium-bronze tubesheet. The tubesheet had the same diameter as the vessel and was welded on to it in an unusual way, as shown below:



One of the welds cracked in service and there was an escape of vapour. Fortunately it did not fire.

The vessel was inspected in 1968 and 1970. Nothing unusual was found but we suspect that no special attention was paid to the bi-metallic welds. The engineers concerned had changed since the start-up of the plant in 1965 and their successors did not know of the unusual construction.

Unusual construction features (and any other unusual features) should be recorded on the pressure vessel registration cards and flagged in pressure vessel inspection schedules; they will then be picked up by Equipment Inspectors.

130/6 NAMES THAT SOUND ALIKE CAN BE CONFUSED

a) Some years ago a clearance was issued to dismantle heat exchanger 347C. The clearance was accepted by the supervisor who gave instructions to the fitter. The fitter thought the supervisor said 347B and unbolted the end of this exchanger. Oil came out, fortunately without injuring anyone.

This incident emphasises that:

Clearances should always be seen by the men who are going to do the job.

It is easy to mishear a letter, particularly on the telephone.

There is a lot to be said for a phonetic alphabet. The International Civil Aviation Authority and other international bodies recommend the following:

A	ALPHA	N	NOVEMBER
B	BRAVO	O	OSCAR
C	CHARLIE	P	PAPA
D	DELTA	Q	QUEBEC
E	ECHO	R	ROMEO
F	FOXTROT	S	SIERRA
G	GOLF	T	TANGO
H	HOTEL	U	UNIFORM
I	INDIA	V	VICTOR
J	JULIET	W	WHISKEY
K	KILO	X	X-RAY
L	LIMA	Y	YANKEE
M	MIKE	Z	ZULU

The numbers of the two exchangers would then become 347 Charlie and 347 Bravo — not so easy to confuse.

Those with wartime memories may prefer to say 347 Baker.

b) If there are three pumps on the same duty, they have in the past been labelled, for example:

J123A, J123B, J123C.

On a new plant the three pumps were called:

J123, JA123, JB123.

Say the names out loud...

Jay 123 and Jayay 123 sound too much alike.

As a result J123 was made live instead of JA123. Both had been isolated and an electrician was asked to make JA123 live.

The old system is better.

130/7 ANOTHER ACCIDENT CAUSED BY THE FAILURE OF EQUIPMENT NOT SUITABLE FOR HEAVY DUTY.

The following extracts from a report issued during the past year show that we take all accidents seriously, not just those that involve chemicals.

SUMMARY

On the day of the accident Mr... . was on a course and had returned to the plant for his lunch.

He sat down and immediately his chair collapsed under him causing him to fall on his back and injure himself.

RECOMMENDATIONS

1 Section Administration Officers (and equivalents) to organise periodic inspection of chairs which are subjected to heavy duty.

2 All furniture purchases should be co-ordinated through Commercial Department.

3 Only chairs of an approved type to be purchased.

4 Until the existing furniture is replaced Section Administration Officers should warn personnel of the dangers inherent in such chairs.

The collapsed chair was inspected by the team and it was noted that the design is such that if a weld failure occurs then complete collapse is more likely than in chairs of an alternative design. It was also noted by the team that these chairs are in constant use round the clock and as a result will have a much shorter life expectancy than those in the main canteen, for instance.

130/8 COMMENTS FROM READERS

a) A reader points out that Newsletter 127/10 on Fires in the Home, left out the obvious preventive measure: Before you go to bed make sure no sources of ignition such as cigarette ends are left lying about.

b) A reader gives another example of the need to test protective equipment (Newsletter 127/2). When he was a boy a keen sailor showed him a new type of life jacket which could be inflated by carbon dioxide. The boy asked for a demonstration but when the cord was pulled nothing happened — the mechanism was blocked with salt.

No doubt the design had been tested in the factory but not after exposure to the weather.

130/9 UNUSUAL ACCIDENTS No.91

A chauffeur employed by another Company, wanting some petrol for cleaning, decided to syphon it from the tank of a works car. He inserted a length of rubber hose into the petrol tank, and then, to fill the hose and start the syphon, he held the end of the hose against the suction nozzle of an industrial vacuum cleaner.

The petrol vapour caught fire and the fire spread to a spillage of petrol on the garage floor. Two cars were destroyed and eleven damaged.

130/10 RECENT PUBLICATIONS

(a) “Dispersion of Heavier-than-Air Gases in the Atmosphere; Review of Research and Progress Report on HSE Activities”, by J McQuaid, available from the Health and Safety Laboratories, West Street, Sheffield S1 2GQ, price 50p.

(b) Loss Prevention Bulletin 029, published by the Institution of Chemical Engineers, described several accidents which occurred when two liquids, which had formed separate layers, were mixed rapidly, for example, by switching on a stirrer. Another incident was described in Newsletter 109, item 2.

(c) ‘Worldwide Data on the Incidence of Multiple-Frequency Accidents”, by L S Fryer and R F Griffiths, (HMSO, £2) contains a series of graphs showing the frequency with which accidents killing various numbers of people have occurred.

Some people are concerned about the accidents that atomic energy **might** cause, but since the war:

581 people have been killed in a single aircraft accident

1700 in a single fire

6000 in a single marine accident

3700 in a single mining accident

300 in a single railway accident.

What are the dangerous technologies?

For more information on any item in this Newsletter please ‘phone ET (Ext. P.2845) or write to her at Wilton. If you do not see the Newsletter regularly and would like your own copy, please ask Mrs. T to add your name to the circulation list.

December 1979

An Engineer's Casebook No. 30
SCREW THREADS IN PIPING SYSTEMS

The Division's policy on screw threads in piping systems is to avoid them wherever possible and their use is banned on process lines up to the first isolation valve. Downstream of this screwed tubing, fittings, valves, reducers etc. are used in the instrument field for pressure gauge connections, for impulse piping, for laboratory sample analysis points etc.

Where screwed piping is used then the preferred thread is the British Standard Pipe thread (BSP). Sizes in common use are ¼ inch BSP for clean gas and liquid duties, $^3/_8$ inch BSP for direct reading pressure gauges and ½ inch BSP for dirty gas or liquids.

Threads may be parallel or taper. Parallel threads require the use of some form of sealing washer to make a pressure tight joint and are used where regular removal of the screwed item is expected and/or its orientation when assembled is required to be in a certain direction. The washer is squeezed between a collar or shoulder and a machined mating face to seal the connection which thus does not rely on the threads for leak tightness.

Taper threads are used for pipe fittings such as barrel nipples, elbows, tees and unions. Both male and female threads are tapered 1 in 16, an angle of approximately 4°. When correctly screwed together all threads are in full engagement with each other and the joint is as strong as, or stronger, than one using parallel threads. Leak tightness using taper/taper threads relies on the thread sealing itself when screwed up tight and can be improved if the threads are wrapped with PTFE tape though this is temperature limited to about 200° C.

Care is necessary when using screwed fittings to ensure that parallel and taper threads are not mismatched. Clearly a male taper pipe thread screwed into a female parallel thread in, say, a needle valve or pressure reducer, results in a weak connection which will be difficult to get pressure tight.

Another potential source of error is the use of the American National Pipe Thread (NPT) series, deliberately or accidentally, instead of the BSP series. ¼ inch and $^3/_8$ inch NPT have 18 threads per inch (tpi) whereas these BSP sizes have 19 tpi. At the ½ inch size both NPT and BSP have 14 tpi. NPT threads are only supplied in the taper/taper form. ¼ inch NPT and ¼ inch BSP fittings will readily screw together, the pitch error is small, and it is possible to get 5 threads engagement, instead of about 6 with properly matched threads, without the use of undue force.

Accidental mixing of NPT and BSP taper threads, whilst incorrect, is unlikely to cause much loss of structural strength. The more serious error is using a taper thread in a parallel hole or vice versa. In this case both structural strength and leak sealing are markedly reduced.

E H Frank

A NEW CONCEPT IN LOSS PREVENTION

During the last decade loss prevention has benefited from a number of new ideas. We have seen the development of numerical methods, and the advantages of simpler plants and plants containing. lower inventories have been pointed out. The following summary of a recent report prepared for the Chemical Industries Association suggests that there is scope for yet more fundamental thinking and that new concepts are on the way.

The moon should be considered as a location for future chemical plants. Construction of plants on the moon will have a number of advantages, namely:-

1 All leaks of toxic or flammable gas or vapour whether deliberate or accidental will disperse very

quickly in the no-atmosphere, low-gravity conditions existing on the moon's surface. This, combined with the absence of oxygen, will make fire or explosion, confined or unconfined, an impossibility and, of course, vapours will not build up to toxic concentrations. Waste disposal will not be a problem.

2 Vacuum processes will be particularly easy to operate as leaks will not occur and there will be no need for vacuum pumps or ejectors.

3 Emulsions will be more stable under the low-gravity conditions. On the other hand liquid-liquid separation will be more difficult.

4 The low-gravity on the moon's surface will make construction much easier. Quite large objects can be erected manually, less lifting gear will be required and that of smaller size than required for terrestrial conditions. This will be an advantage for maintenance as well as construction. Dependence on riggers will be reduced.

5 Any objects dropped during construction, operations or maintenance will be much less likely to cause damage or injury or to be damaged themselves.

Falls of persons will be less serious.

Falls of persons and objects are the cause of a large proportion of industrial accidents and the lost-time accident rate should therefore be reduced (unless people climb higher without protection).

6 Design and operation will be free from the restraints imposed by unnecessarily restrictive legislative requirements. The Health and Safety at Work Act will not apply.

7 The long lunar day (equal to 14 terrestrial days) will enable construction to proceed for long periods without interruption.

It is recognised that there are some initial disadvantages. Construction materials and raw materials will have to be transported from the Earth and products returned to it. However, these objections apply to **any** new site and the chemical industry will have to face up to them sooner or later as existing sites become full. The reductions in the cost of space travel expected in the next few decades, (see Process Engineering, Feb 1979, p. 30) together with the advantages listed above, may well make lunar plants economic. In time, some indigenous raw materials may be developed and, as other plants are installed, the benefits of integration will be felt.

Copies of the full report, "Project Moonshine" are unfortunately difficult to obtain.